

Application Note: A Dual *PIC-STEP* Based Microstepping Controller Using the A3967SLB Driver

- Integrated controller/driver independently operates 2 stepper motors
- Uses the *PIC-STEP* motion control chip
- Full, half, quarter, and eighth step resolution
- 750 mA continuous current per driver
- Motor supply voltage from 5.0v to 30v
- RS232 interface to controller
- CAD files included

1.0 Overview

This application note describes the construction of a dual integrated stepper controller/driver using the *PIC-STEP* motion control chip and the A3967SLB microstepping driver from Allegro MicroSystems. This application note includes schematic and PCB layout files for fabricating circuit boards using ExpressPCB software (available from expresspcb.com at no charge). The following additional files are included:

| | |
|--------------|---------------------------|
| DUALSTEP.SCH | Schematic file |
| DUALSTEP.PCB | PCB layout file |
| DUALSTEP.TXT | Part list for the circuit |

2.0 The *PIC-STEP* Controller

The *PIC-STEP* is a single chip motion control system which interfaces to standard serial ports and to drivers with little additional circuitry. It provides stepper control and motion profiling functions as well as many other features which are needed for a complete motion control system. Please download the data sheet PICSTEP.PDF from jrkerr.com/docs.html for complete details on the functionality and use of the *PIC-STEP* controller chip.

3.0 The A3967SLB Driver

The A3967SLB microstepping motor driver operates stepper motors in full, half, quarter, and eight-step modes. It comes with a built-in translator which simplifies microstepping control: two logic inputs set the microstepping mode (full, half, quarter, and eight), one logic input sets the motor direction, and one logic input steps the motor.

The A3967SLB requires two supply voltages: a 5.0v logic supply, and a 5.0v to 30v motor supply. Its bipolar chopper drive has an output drive capability of up to +/- 750 mA which is controlled using an external sense resistor and a voltage applied to a reference voltage input.

To reduce audible motor noise, increase step accuracy, and reduce power dissipation, the A3967SLB has the ability to operate in slow, fast, or mixed current-decay modes. The decay mode is controlled by a voltage applied to a percent fast decay input.

... CAUTION ...

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The A3967SLB comes with internal circuit protection that includes thermal shutdown with hysteresis, under-voltage lockout, and crossover-current protection.

4.0 The Application Circuit

The application circuit is shown in Figure 1. This is the same schematic as found in the file DUALSTEP.SCH.

4.1 Communications

The **PIC-STEP** Microstepping Controller uses RS232 for host communication. The default baud rate is 19,200, but it may be changed at any time up to 115,200. The communication protocol uses 1 start bit, 1 stop bit and no parity. Please refer to the **PIC-STEP** chip data sheet PICSTEP.PDF from jrkerr.com/docs.html for a complete explanation of the communications protocol and command set.

4.2 Motor Interface

Two 4 pin jumpers **JP6** and **JP5** are used to drive motor A and motor B respectively. Optional motor overtemperature shutdown is available by applying an analog voltage to pin 2 of Controller Connectors **JP5** and **JP4**. Typically this input is tied to a thermistor bridge (not provided) which lowers its voltage as the temperature rises. If this input is not used for motor thermal shutdown, it can be used as a general purpose analog input.

4.3 Current Output

The Dual **PIC-STEP** Microstepping Controller components limit the maximum motor output current per phase to 750 mA. The running current limit and hold current limit is set by the **PIC-STEP** Set Parameters command. Setting the running or hold current limit values to full scale (255) corresponds to the maximum output current of 750 mA. The minimum run or hold current value is 50, corresponding to a current of 150 ma. By changing the values of the current sense resistors (R15 and R16, or R17 and R18), you can change the range of output currents available.

4.4 Microstepping Mode

The A3967SLB microstepping mode is controlled by setting the **PIC-STEP** OUT1 and OUT2 outputs using the Set Output command. The microstep resolution truth table is shown in Table 1.

| OUT1 | OUT2 | Resolution |
|------|------|---------------------|
| L | L | Full Step (2 phase) |
| H | L | Half Step |
| L | H | Quarter Step |
| H | H | Eighth Step |

Table 1 – Microstep Resolution Truth Table

4.5 Decay Mode

The A3967SLB decay mode (slow, fast, and mixed-decay) is set by the voltage applied to the PFD input. On the Dual **PIC-STEP** Microstepping Controller Board a resistor divider (R13-R14

Motor temperature sensing is available on the Dual **PIC-STEP** Microstepping Control Board through pin 2 of Controller Connections **JP5** and **JP4**. This input can be tied to a thermistor bridge (not provided) which lowers its voltage as the temperature rises.

4.9 Connector Pin Definitions

Motor Power Connector **JP2** (1x2 pin header – 0.100” spacing)

(Use only if motor power is **not** supplied from logic power via **JP8**)

| <i>Pin</i> | <i>Definition</i> |
|------------|---|
| 1 | Motor Power Supply 5.0- 30vdc - <i>near top edge of board next to capacitor</i> |
| 2 | Motor Power Supply Ground (connected internally to logic ground) |

Logic Power Connector **JP1** (1x2 pin header - 0.100” spacing)

| <i>Pin</i> | <i>Definition</i> |
|------------|--|
| 1 | Logic Power Supply 7.5 - 16vdc (towards the lower edge of board next to DB9) |
| 2 | Ground |

Motor A and Motor B Connectors **JP6, JP7** (1x4 pin header – 0.100” spacing)

| <i>Pin</i> | <i>Definition</i> |
|------------|-------------------|
| 1 | Phase 1A |
| 2 | Phase 1B |
| 3 | Phase 2A |
| 4 | Phase 2B |

Jumper **JP8**

(Use only if motor power is **not** supplied from Motor Power Connector **JP2**)

| <i>Jumper</i> | <i>Description</i> |
|---------------|--|
| JP8 | Motor power interconnection. Inserting JP8 connects motor power to logic connector JP1, allowing the use of a single 7.5 to 16v supply. Use this jumper only when the motor power supply jumper JP2 is disconnected. |

RS232 Connector **JP3** (female DB9 connector)

| <i>Pin</i> | <i>Definition</i> |
|-------------|----------------------|
| 2 | Transmit Data Output |
| 3 | Receive Data Input |
| 5 | Ground |
| 1,4, 6-9 | Not Used |

Controller A and Controller B Connectors **JP5, JP4** (1x10 pin header - 0.100" spacing)
 These pins are tied to **PIC-STEP** Controller input and output pins

| Pin | Definition |
|-----|--|
| 1 | Ground |
| 2 | TEMP_SENS analog input (0-5vdc). This input can be tied to a thermistor bridge which lowers its voltage as the temperature rises. This can also be used as a general purpose analog input. |
| 3 | OUT4 output. This general purpose output is initialized LOW |
| 4 | LIMIT1 input. This input is used as the forward limit switch, and can be used for homing or as a general purpose input bit as well. (This signal has an internal pull-up resistor to +5v) |
| 5 | HOME_SW input. This input can be used for homing or as a general purpose input bit. (This signal has an internal pull-up resistor to +5v) |
| 6 | IN2 input. General purpose input pin. |
| 7 | LIMIT2 input. This input is used as the reverse limit switch, and can be used for homing or as a general purpose input bit as well. (This signal has an internal pull-up resistor to +5v) |
| 8 | IN1 input. General purpose input pin. |
| 9 | ESTOP input. A HIGH input on this pin will terminate any motion. (This signal has an internal pull-up resistor to +5v) |
| 10 | Logic Power (5vdc) |

5.0 Fabrication

This application note includes files for fabricating the circuit board shown in Figure 2. These files were generated by software available from ExpressPCB.com. ExpressPCB is a low-cost service for fabricating quick-turn prototype circuit boards. To use these files, download the Schematic and Layout programs from ExpressPCB.com. Follow the instructions included with the software for opening the files and for ordering circuit boards.

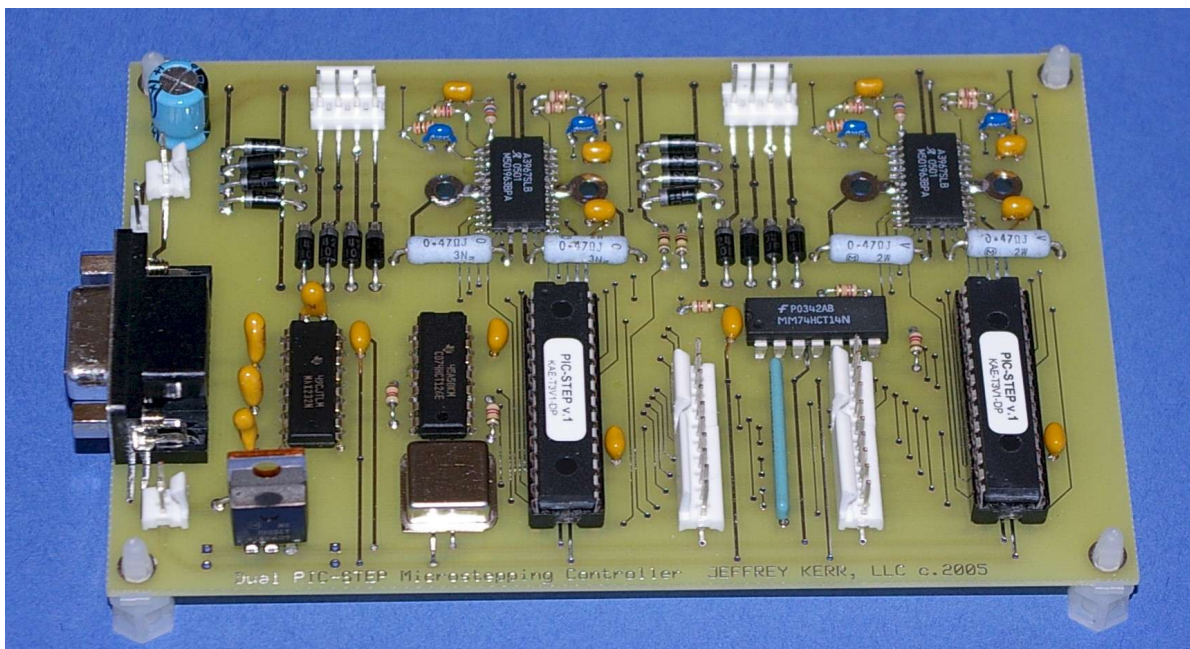


Figure 2 – Dual **PIC-STEP** Microstepping Controller Board

This application board was designed using ExpressPCB's "Standard" service. The boards come without a solder mask or silkscreen legend, so you will need to print out the silkscreen layer to assist you in populating the board with components. With the same CAD files, you also can order boards using the ExpressPCB "ProtoPro" service which will include the solder mask and silk screen legend. (Note that when you order these boards, you are not ordering prefabricated boards – they will be fabricated according to the data in your .PCB file.)

All of the components on this board are thru-hole components except for the A3967SLB driver, which you will probably want to solder in place first. Note that without the solder mask, you must take care in soldering the components with metal parts that might come in contact with underlying traces.

All the parts required for this board are listed in the file DUALSTEP.TXT. This file also includes Digikey part numbers (see digikey.com) for convenience. The **PIC-STEP** chip can be ordered from jrkerr.com/orders.html.

6.0 Using the Controller

The Dual **PIC-STEP** Microstepping Controller Board is very easy to operate. Here are some tips to get started:

1. Verify the operation of the board using the NMC Test program *nmctest.zip* found in jrkerr.com/software.html. This Windows test utility program will allow you to test all functions of the Dual **PIC-STEP** Microstepping Controller Board and verify the operation of your motors.
2. First verify RS232 communications with the **PIC-STEP** chips, then verify motor operation.
3. From the NMC Test **PIC-STEP** Properties window, set the Ignore Limits and Ignore Estop check boxes. This will allow testing without setting any of the Controller Connector pins on **JP4** and **JP5**.
4. The A3967SLB's can generate a lot of heat. Holes with heat conducting pads on either side of each driver chip are provided for mounting a heat sink if necessary.
5. The Dual **PIC-STEP** Microstepping Controller Board described here provided as an example and is not intended for commercial use.